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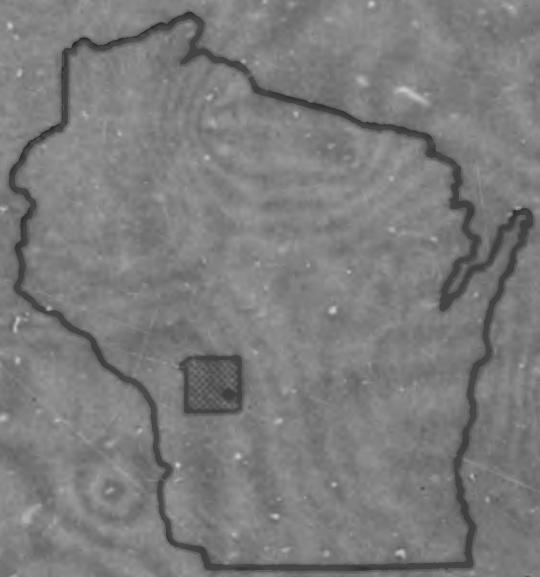
INCOMPLETED

FLOOD INSURANCE STUDY

ORIGINAL

VILLAGE OF KENDALL, WISCONSIN

MONROE COUNTY



SEPTEMBER 18, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER 550287

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TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
1.1	Purpose of Study	1
1.2	Authority and Acknowledgments	1
1.3	Coordination	2
2.0	AREA STUDIED	2
2.1	Scope of Study	2
2.2	Community Description	2
2.3	Principal Flood Problems	2
2.4	Flood Protection Measures	4
3.0	ENGINEERING METHODS	4
3.1	Hydrologic Analyses	4
3.2	Hydraulic Analyses	5
4.0	FLOOD PLAIN MANAGEMENT APPLICATIONS	6
4.1	Flood Boundaries	6
4.2	Floodways	7
5.0	INSURANCE APPLICATION	10
5.1	Reach Determinations	10
5.2	Flood Hazard Factors	11
5.3	Flood Insurance Zones	11
5.4	Flood Insurance Rate Map Description	11

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TABLE OF CONTENTS (Continued)

		Page
6.0	OTHER STUDIES	13
7.0	LOCATION OF DATA	13
8.0	REFERENCES AND BIBLIOGRAPHY	13

FIGURES

Figure	1	- Vicinity Map	3
Figure	2	- Floodway Schematic	10

TABLES

Table	1	- Summary of Discharges	5
Table	2	- Floodway Data	8
Table	3	- Flood Insurance Zone Data	12

EXHIBITS

Flood Profiles

Main Branch Baraboo River	Panels	01P - 03P
West Branch Baraboo River	Panels	04P - 05P
North-west Branch Baraboo River	Panel	06P

Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map

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FLOOD INSURANCE STUDY

VILLAGE OF KENDALL,
MONROE COUNTY,
WISCONSIN

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Village of Kendall, Monroe County, Wisconsin, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

This Flood Insurance Study was prepared by compiling existing hydrologic and hydraulic technical and scientific data prepared originally for purposes other than the National Flood Insurance Program. The data were identified as the best available at the time of compilation of this Flood Insurance Study and should depict the general conditions of the flooding sources with relative accuracy. The Federal Emergency Management Agency (FEMA) performed a cursory review and accepted the data as valid for purposes of this Flood Insurance Study and the National Flood Insurance Program. However, if better information is known to exist or has been developed since the date of this report, the information should be immediately forwarded to the Natural and Technological Hazards Division, FEMA, Chicago, Illinois, for consideration for revision of this study.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were obtained from "Kendall, Wisconsin Floodplain Study" (Reference 1).

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1.3 Coordination

On October 29, 1985, the results of this Flood Insurance Study were reviewed and accepted at a final coordination meeting attended by representatives of the community and FEMA.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Village of Kendall, Monroe County, Wisconsin. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected based on the extent and validity of available existing hydrologic and hydraulic data.

Main Branch Baraboo River, West Branch Baraboo River, and North-west Branch Baraboo River were studied in detail.

Approximate methods of analysis were used to study all remaining areas having a potential flood hazard that did not have detailed scientific or technical data available.

2.2 Community Description

The Village of Kendall is located in west-central Wisconsin in Monroe County. The village is surrounded by the unincorporated areas of Monroe County. In 1980, the population of Kendall was reported to be 486 (Reference 2).

The Kendall area is characterized by uneven and hilly terrain and steep stream slopes. The soils are generally sands and sandy loams.

The climate in west-central Wisconsin is characterized by wide variations in temperature. Annual average precipitation of the region is 30 inches, with an average snowfall of 48 inches. Precipitation is normally higher in the spring and summer months (Reference 3).

About 30 percent of the Kendall drainage area is woodland, 3 percent residential, 55 percent cultivated croplands, 6 percent pasturelands, and 1 percent paved streets.

2.3 Principal Flood Problems

The history of flooding on the streams within Kendall indicates that flooding may occur during any season of the year. Kendall has minor spring flooding almost every year. On July 1, 1978, Kendall experienced a major flooding event that caused damage to several structures located in the flood plain. History also indicates that the village experienced another flood in 1935 that was greater in magnitude than the 1978 flood (Reference 1).

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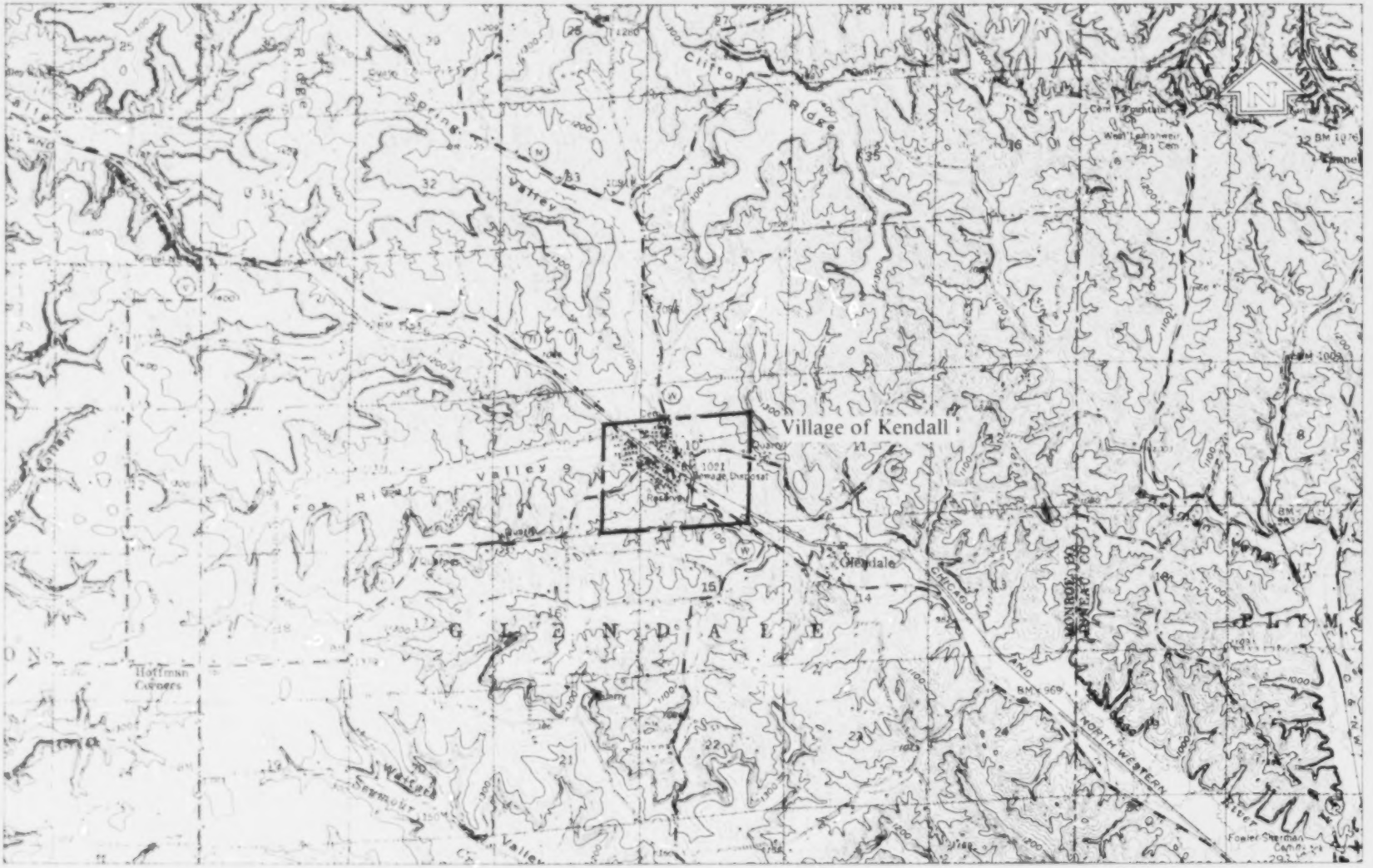

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

VILLAGE OF KENDALL, WI

(MONROE CO.)

APPROXIMATE SCALE

1 0 1 2 3 MILES

VICINITY MAP

2.4 Flood Protection Measures

Flood protection measures do not exist within the study area.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each riverine flooding source studied in detail affecting the community.

The U.S. Army Corps of Engineers (COE) HEC-1 computer program was used in the hydrologic analysis. The basic aspects of the HEC-1 computer program are a precipitation method, a routing method, and a unit hydrograph method. The precipitation method chosen was the hypothetical storm because no rainfall data were available. The hypothetical storm was distributed over time using the 24-hour Type II storm distribution. The Muskingham method was the routing method used. Finally, the U.S. Soil Conservation Service unit-hydrograph method was selected to analyze the rainfall event. Based on all these methods, peak discharges for Main Branch Baraboo River, West Branch Baraboo River, and North-west Branch Baraboo River were calculated (Reference 4).

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

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TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ MILES)	PEAK DISCHARGE (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
MAIN BRANCH BARABOO RIVER					
about 0.2 mile downstream of South Railroad Street	16.72	2,740	4,500	5,535	7,030
just upstream of the confluence of West Branch Baraboo River	7.41	1,160	1,1910	2,370	3,030
WEST BRANCH BARABOO RIVER					
just downstream of the confluence of North-west Branch Baraboo River	4.27	790	1,290	1,580	2,000
NORTH-WEST BRANCH BARABOO RIVER					
just upstream of the confluence with West Branch Baraboo River	0.9	720	1,190	1,470	1,875

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross sections, bridge elevation data, and structural data for the hydraulic analysis were provided by Mr. Ronald L. Parish, R.L.S., contracted by the Village of Kendall.

Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen based on field observations and engineering judgment. The Manning's "n" values ranged from 0.030 in the channel to 0.17 in the overbanks.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the Flood Boundary and Floodway Map.

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The water-surface elevations were computed using the COE HEC-2 step-backwater computer program (References 5 and 6). The analysis presented many problems related to steep channel slopes, constricting bridge openings, and divided flow. The steep channel slopes made the computer analysis sensitive to minor changes. The bridge openings throughout Kendall are very constricting; in particular, the Thayer Street bridge opening is small. The Thayer Street bridge gives approximately a 2-foot increase in water-surface elevations upstream of the bridge on West Branch Baraboo River. The increase diverts flow from the stream, which then travels down Water Street and back into the channel at cross sections D and E. Therefore, the divided flow option was used in the HEC-2 program. This was a balancing act of matching the upstream elevations at a specified cross section.

Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence intervals. In cases where the 50- and 100-year flood elevations are close together, due to limitations of the profile scale, only the 100-year profile has been drawn.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations shown on the profiles are, thus, considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD).

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using aerial photos at a scale of 1:6000 (Reference 7).

For the streams studied by approximate methods, only the 100-year flood plain boundary was delineated using aerial photos provided by the Wisconsin Department of Natural Resources (WDNR) (Reference 7) and the Flood Hazard Boundary Map for the Village of Kendall (Reference 8).

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The 100-year flood plain boundaries are shown on the Flood Boundary and Floodway Map. In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces the flood-carrying capacity, increases the flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. However, the WDNR has established a policy that limits encroachment in the flood plain to 0.1 foot (Reference 9).

The floodways presented in this study were computed on the basis of effective flow on either side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed and are presented in Table 2, Floodway Data.

As shown on the Flood Boundary and Floodway Map, the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and the 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 0.1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
MAIN BRANCH BARABOO RIVER								
A	1495	305	1653	6.0	1009.0	1009.0	1009.0	0.0
B	2300	68	398	13.9	1009.0	1009.0	1009.0	0.0
C	2520	63	483	13.7	1010.5	1010.5	1010.5	0.0
D	2700	89	740	10.9	1012.6	1012.6	1012.6	0.0
E	3040	199	1467	5.8	1014.2	1014.2	1014.2	0.0
F	3540	268	1118	6.4	1014.4	1014.4	1014.4	0.0
G	3760	200	1638	2.2	1014.9	1014.9	1014.9	0.0
H	4395	280	1099	3.8	1015.6	1015.6	1015.6	0.0
I	4975	260	549	8.2	1016.0	1016.0	1016.0	0.0

[1]FEET ABOVE CORPORATE LIMITS

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

VILLAGE OF KENDALL, WI

(MONROE CO.)

FLOODWAY DATA

MAIN BRANCH BARABOO RIVER

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
WEST BRANCH BARABOO RIVER								
A	295	99	520	4.8	1015.3	1015.3	1015.3	0.0
B	595	246	630	5.5	1015.6	1015.6	1015.6	0.0
C	920	142	411	6.4	1015.8	1015.8	1015.8	0.0
D	975	200	922	4.5	1018.9	1018.9	1018.9	0.0
E	1320	368	1362	4.8	1019.1	1019.1	1019.1	0.0
F	1635	231	727	8.3	1019.5	1019.5	1019.5	0.0
G	2070	57	202	12.8	1020.7	1020.7	1020.7	0.0
H	2485	139	394	6.6	1023.6	1023.6	1023.6	0.0
I	2540	134	432	6.1	1024.0	1024.0	1024.0	0.0
J	3080	228	596	5.4	1024.9	1024.9	1024.9	0.0
NORTH-WEST BRANCH BARABOO RIVER								
A	140	163	466	5.9	1020.1	1020.1	1020.1	0.0
B	670	54	170	11.6	1021.5	1021.5	1021.5	0.0
C	1080	232	625	5.0	1024.3	1024.3	1024.3	0.0

[1]FEET ABOVE MOUTH

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

VILLAGE OF KENDALL, WI

(MONROE CO.)

FLOODWAY DATA

WEST BRANCH BARABOO RIVER—NORTH-WEST BRANCH BARABOO RIVER

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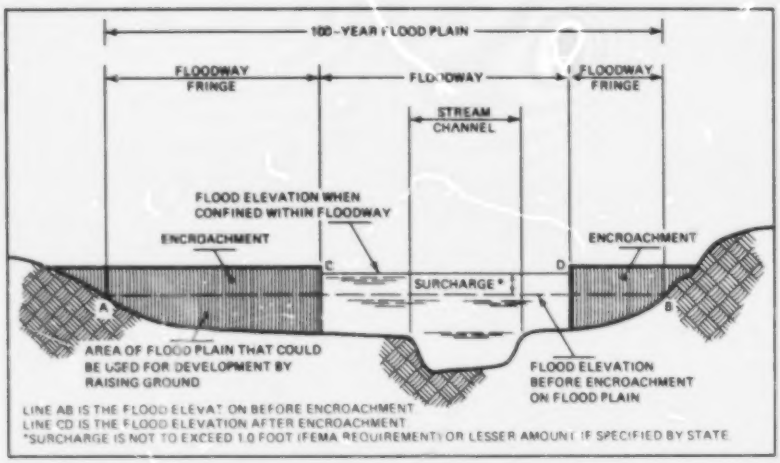
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE *
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FIGURE 2 - Floodway Schematic

The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting the Village of Kendall.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the weighted average difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the riverine flooding sources of the Village of Kendall are shown on the Flood Profiles and summarized in Table 3, Flood Insurance Zone Data.

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5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a riverine reach is the weighted average difference between the 10- and 100-year flood water-surface elevations rounded to the nearest 0.5 foot, multiplied by 10, and shown as a 3-digit code. For example, if the difference between elevations is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations are shown or FHFs determined.
Zones A3, A6:	Special Flood Hazard Areas inundated by the 100-year flood, with base flood elevations shown, and zones subdivided according to FHFs.
Zone C:	Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are summarized in Table 3, Flood Insurance Zone Data.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Village of Kendall is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines for riverine flooding sources show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

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6.0 OTHER STUDIES

A Flood Insurance Study has been published for the Unincorporated Areas of Monroe County (Reference 10). That study is superseded by this report. There is a discrepancy in floodway boundaries between the two studies, but this study for the Village of Kendall should be considered the more accurate due to the use of aerial photography. The discrepancy does not affect any other data in this study.

Due to its more detailed analysis, this Flood Insurance Study supersedes the previously printed Flood Hazard Boundary Map for the Village of Kendall (Reference 8).

7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, 300 South Wacker Drive, Chicago, Illinois 60606.

8.0 REFERENCES AND BIBLIOGRAPHY

1. Wisconsin Department of Natural Resources, Kendall, Wisconsin Floodplain Study, December 1982.

2. U.S. Department of Commerce, Bureau of the Census, 1980 Census of Population, Number of Inhabitants, Wisconsin, Washington, D.C., February 1982.

3. ————, Weather Bureau, Technical Paper No. 40, Rainfall Frequency Atlas of the United States, Washington, D.C., January 1963.

4. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, Computer Program 823-X6-L2610, Davis, California, January 1973.

5. ————, HEC-2 Water-Surface Profiles, Users Manual, January 1981.

6. ————, HEC-2 Water-Surface Profiles, Generalized Computer Program, Davis, California, April 1984.

7. Wisconsin Department of Natural Resources, Aerial Photos, Kendall, Wisconsin, Scale 1:6000, May 1982.

8. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Village of Kendall, Monroe County, Wisconsin, April 1976.

9. Wisconsin Department of Natural Resources, Wisconsin's Flood Plain Management Program, Chapter NR 116, Register No. 259, 1977.

10. Federal Emergency Management Agency, Flood Insurance Study, Monroe County, Unincorporated Areas, Monroe County, Wisconsin, May 1982.

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (FEET NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
MAIN BRANCH BARABOO RIVER							
REACH 1	0001	−3.1	−1.1	1.2	030	A6	VARIES—SEE MAP
REACH 2	0001	−1.6	−0.7	1.1	015	A3	VARIES—SEE MAP
WEST BRANCH BARABOO RIVER							
REACH 1	0001	−3.1	−1.2	1.8	030	A6	VARIES—SEE MAP
REACH 2	0001	−1.3	−0.4	0.9	015	A3	VARIES—SEE MAP
NORTH-WEST BRANCH BARABOO RIVER							
REACH 1	0001	−1.6	−0.5	0.9	015	A3	VARIES—SEE MAP

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

TABLE 3

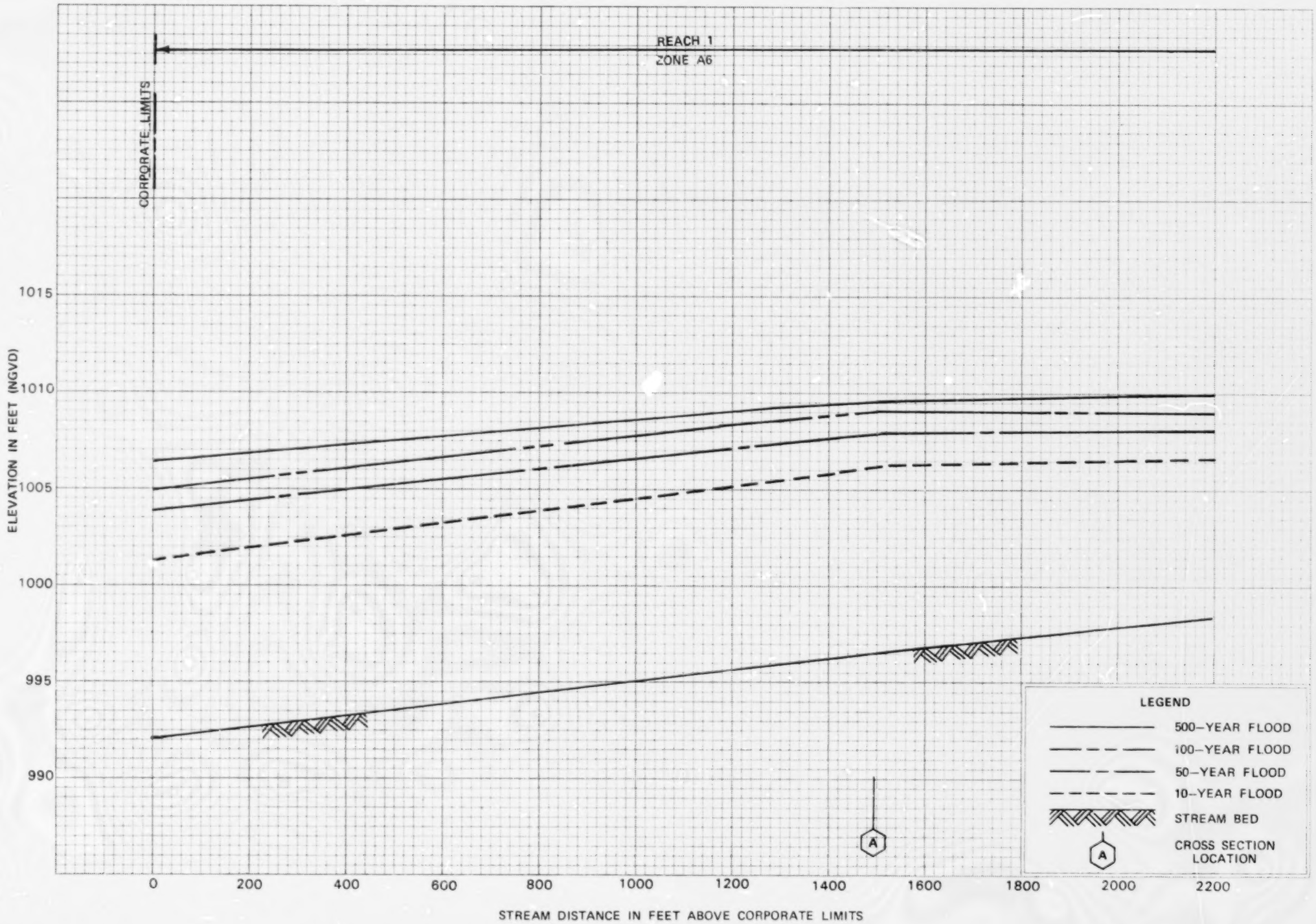
FEDERAL EMERGENCY MANAGEMENT AGENCY

VILLAGE OF KENDALL, WI

(MONROE CO.)

FLOOD INSURANCE ZONE DATA

MAIN BRANCH BARABOO RIVER — WEST BRANCH BARABOO RIVER— NORTH-WEST BRANCH BARABOO RIVER



FLOOD PROFILES

MAIN BRANCH BARABOO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

VILLAGE OF KENDALL, WI
(MONROE CO.)

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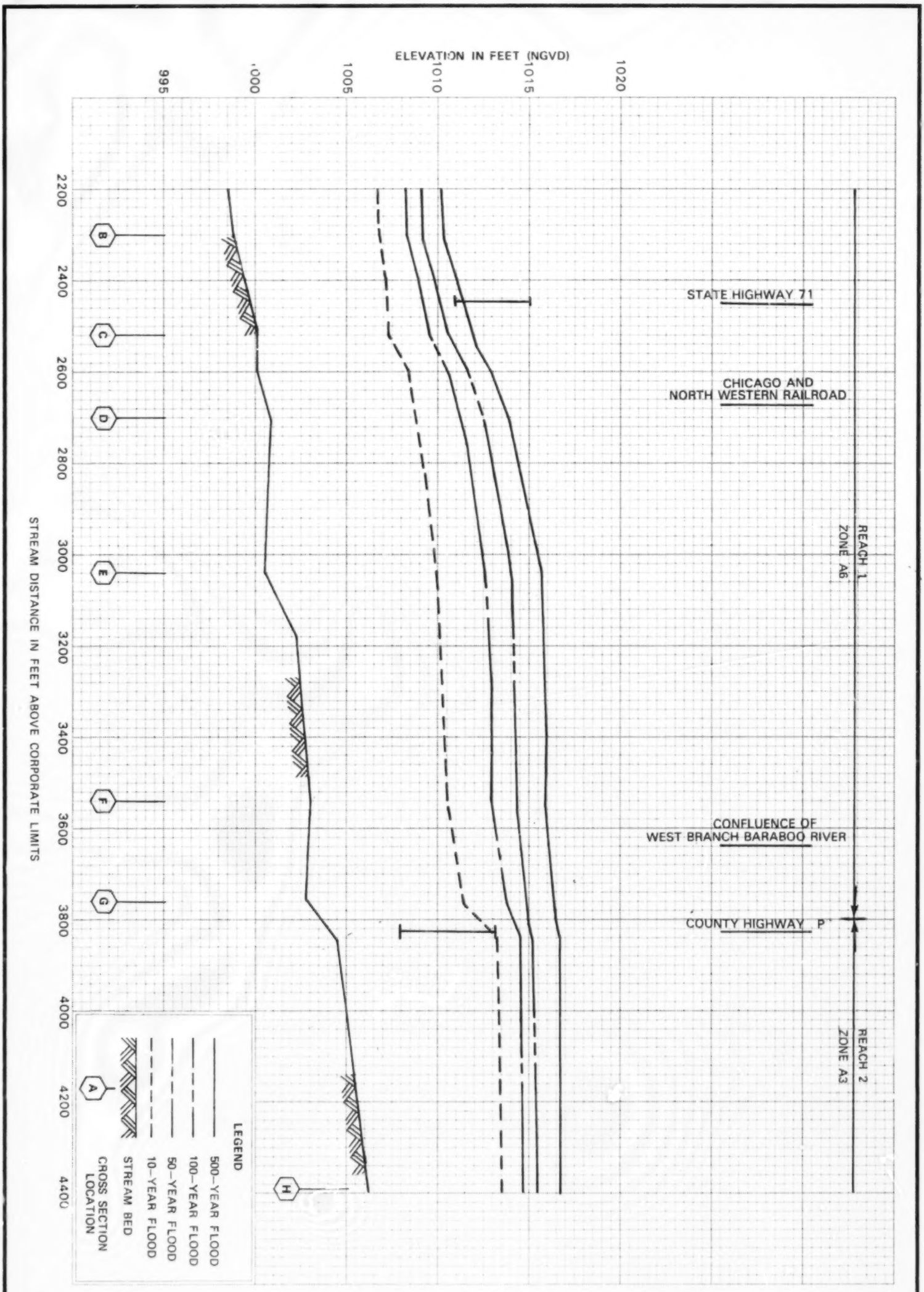

02P	FEDERAL EMERGENCY MANAGEMENT AGENCY VILLAGE OF KENDALL, WI (MONROE CO.)	FLOOD PROFILES MAIN BRANCH BARABOO RIVER

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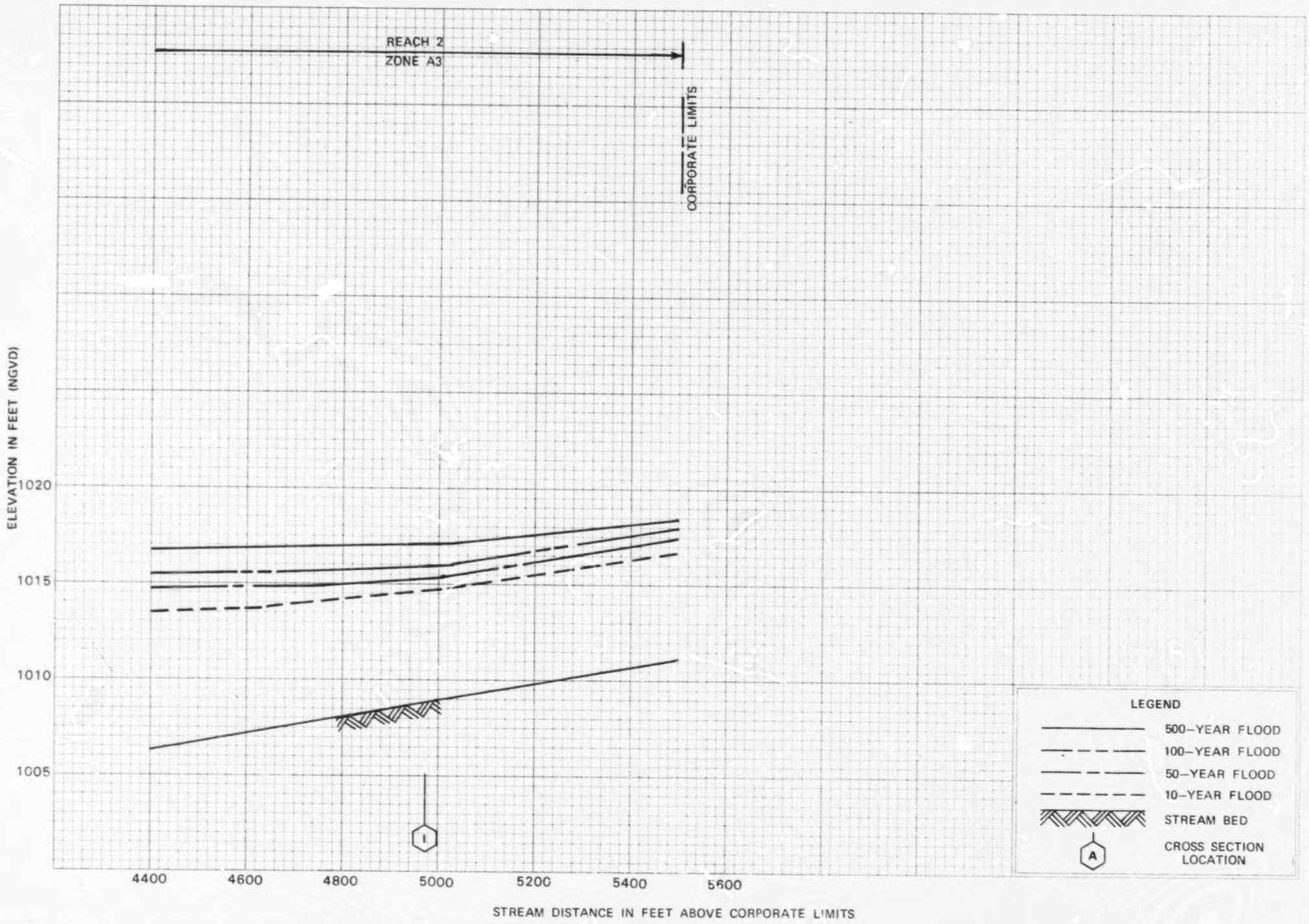

FLOOD PROFILES

MAIN BRANCH BARABOO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

VILLAGE OF KENDALL, WI

(MONROE CO.)

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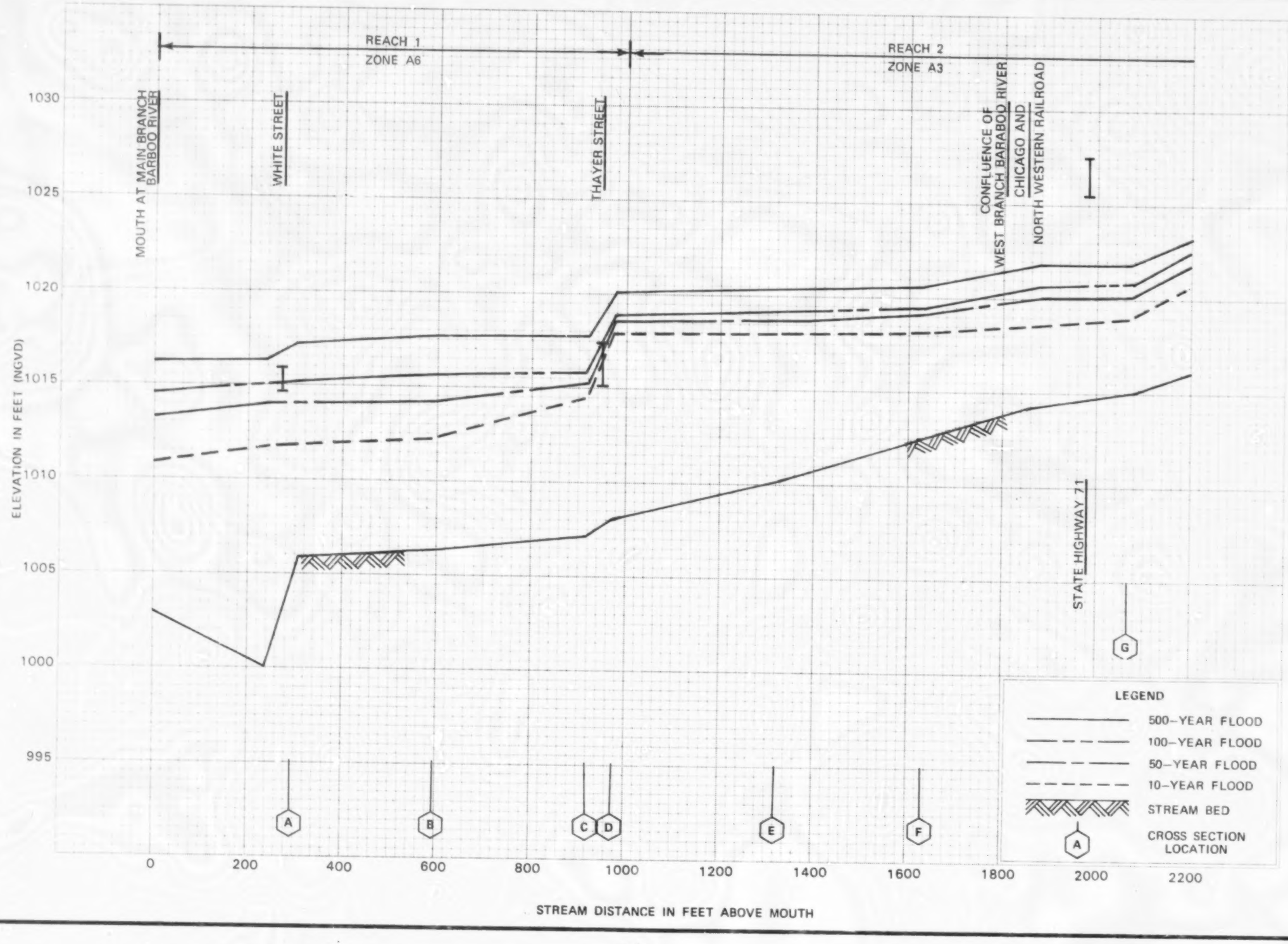

FLOOD PROFILES

WEST BRANCH BARABOO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

VILLAGE OF KENDALL, WI

(MONROE CO.)

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FLOOD PROFILES

WEST BRANCH BARABOO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

VILLAGE OF KENDALL, WI

(MONROE CO.)

05P

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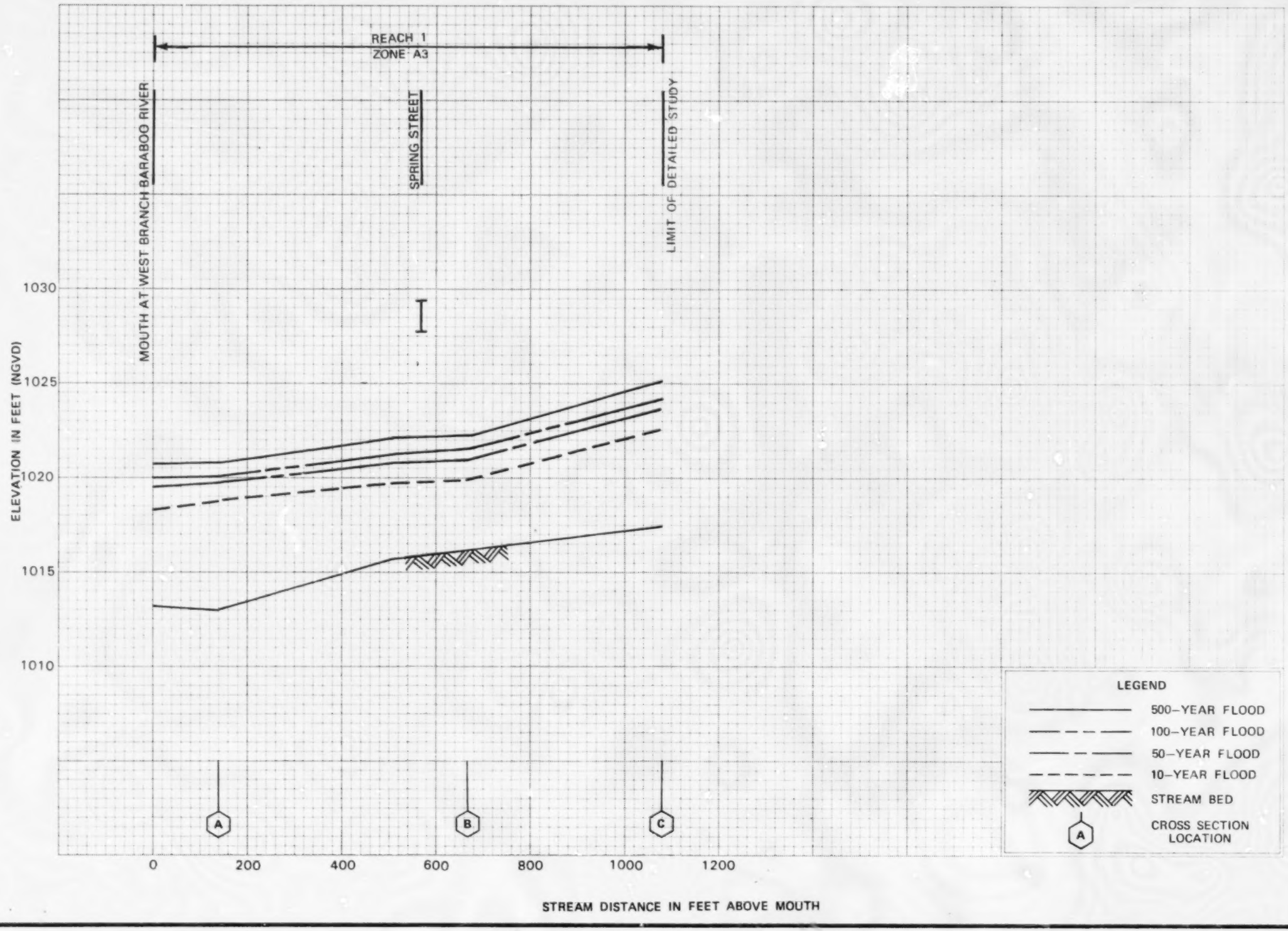

FLOOD PROFILES

NORTH-WEST BRANCH BARABOO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

VILLAGE OF KENDALL, WI

(MONROE CO.)

06P

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